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ABSTRACT

A time series procedure, the Shewart Technique, was used in an educational setting with eight academically deficient students to increase the percent of assignments completed. Ss were given mediation training and behavior contracts. The Shewart Technique was found to be useful in providing a formative analysis for intervention. (Tables and graphs with statistical data are provided.) (SBH)

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AN APPLICATION OF THE SHEWART TIME SERIES DESIGN IN AN EDUCATIONAL SETTING

The single subject (N=1) design is becoming increasingly popular in educational settings (McLaughlin, in press). With the increased use of operant technology, the need for statistical evaluation of these strategies has become obvious. The assumptions underlying familiar parametric and nonparametric statistics are often violated when they are used to evaluate the single subject design. For this reason, time series procedures have been suggested as appropriate for determining statistical significance when the single subject design is used. The present paper details one attempt to apply a time series procedure called the Shewart Technique in an educational setting.

THE STUDY

The objective of this study was to increase the percent of assignments completed by eight academically deficient students. The procedures used to effect this change included mediation training and a behavior contract placed on the students' desks. The students received one hour of mediation training using a procedure defined by Blackwood (1970). The training consisted of a role played incident in which students were to respond to four questions appropriate to the development of the verbal chain which is the end result of mediation training. A chart placed on each students' desk allowed them to count each assignment as it was completed. From this data, the percent of assignments completed each day was computed and compared to baseline. Figure 1 contains a graphic display of each students' performance.

THE SHEWART TECHNIQUE

A check on the independence of the baseline data is necessary before

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the Shewart Technique can be used. This check determines whether the baseline data is autocorrelated. If intervention data is predictable from baseline, the data are autocorrelated and any claims of an effective intervention would be invalid.

Gottman (1974) presents what he calls an approximate determination of significant autocorrelation. The formula he presents was developed by Bartlett (1946), it consists of the comparison of the first order autocorrelation coefficient (r_1) to the Bartlett formula ($2/\sqrt{N}$). This computation for one subject from the present study is presented in Table 1. If the baseline data is significantly autocorrelated ($r_1 > 2/\sqrt{N}$) transformation procedures are necessary before the Shewart Technique can be used. Since transformation was not necessary for the present study the reader is referred to Gottman for specific procedures.

When baseline data are independent, the next step is to compute the Shewart formula. The standard deviation of the baseline data is determined and a two standard deviation band width is established. Since the chance expectation of any data points exceeding the two standard deviation band is less then five times out of 100 (.05), the level of significance is readily defined. Gottman suggested that the intervention be stopped and significance claimed when two intervention data points fall outside the second band. The results of this procedure when applied to the present study appears in Figure 1.

EVALUATING THE PRESENT STUDY

Determining Autocorrelations

Table 2 presents the comparison of r_1 to $2/\sqrt{N}$, for the present research. One of the autocorrelation coefficients exceeded $2/\sqrt{N}$ but had a negative sign. The possibility of the baseline data being negatively correlated was discarded for two reasons. A visual inspection of the baseline did not indicate auto-

correlation and the idea of negative autocorrelation did not seem to make sense.

DETERMINING SIGNIFICANCE

The extreme oscillation in the baseline data failed to produce significant autocorrelation, however, it did cause problems in determining whether significant changes occurred from baseline to intervention. Although four of the eight subjects evaluated in the present study increased their percent of assignments completed beyond the .05 level on one or more days, the other four subjects each had such large variance in their baseline data that obtaining significance was impossible. Each of the four subjects had to complete more than 100% of his assignments to reach significance. The .05 level was 105, 116, 130 and 105%, for subjects 1, 2, 4 and 5, respectively. Some smoothing effect resulted from applying a moving averages transformation to the baseline data. This procedure averages successive days percentages into 1 data point. In the present study insufficient data points were available to use this transformation effectively. Baseline and intervention of 10-15 data points for each condition would probably be necessary..

The two standard deviation band width used by Gottman to establish the significance level at .05 is inappropriate when a direction of change is predicted. In the present study a subject who performed beyond two standard deviations above the mean would actually have demonstrated significant change at the .025 level. Since the .05 level actually falls 1.8 standard deviations above the mean, this figure was used to establish the success criterion in the present study.

To summarize, the technique was useful in providing a formative analysis for the intervention. After gathering baseline data, the two standard deviation band can be used to define a successful change. The intervention can continue

until that predefined level is met. Wide fluctuation in baseline data may set this goal at a level that is impossible to meet, unless extensive data are collected in each condition, and the moving averages transformation is used.

BIBLIOGRAPHY

Blackwood, Ralph O., Operant Control of Behavior, Exordium Press, Akron, Ohio, 1970.

Gottman, J. M. and Leiblum, S. R., How to do psychotherapy and how to evaluate it. Holt, Rinehart, and Winston, New York, N. Y. 1974.

Bartlett, _____

Cited by Gottman, J. M., and Lieblum, S. R., How to do psychotherapy and how to evaluate it, Holt, Rinehart, and Winston, New York, N. Y., 1974.

McLaughlin, T. F. An examination and evaluation of single subject designs used in behavior analysis research on school settings. Contemporary Educational Psychology, 1977, in press.

TABLE 1

Subject #3 Day
Data % Completed

BASELINE					INTERVENTION				
1	2	3	4	5	6	7	8	9	10
0	33	67	67	67	100	100	68	100	100

Assignment Completion for S #3

Autocorrelation

$$r_1 = \frac{(Z_1-\bar{Z})(Z_2-\bar{Z}) + (Z_2-\bar{Z})(Z_3-\bar{Z}) + \ldots + (Z_{N-1})(Z_N-\bar{Z})}{(Z_1-\bar{Z})^2 + (Z_2-\bar{Z})^2 + \ldots + (Z_N-\bar{Z})^2}$$

$$r_1 = \frac{(0-47)(33-47) + (33-47)(67-47) + (67-47)(67-47) + (67-47)(67-47)}{(0-47)^2 + (33-47)^2 + (67-47)^2 + (67-47)^2 + (67-47)^2}$$

$$r_1 = \frac{(658) + (-280) + (400) + (400)}{2203 + 196 + 400 + 400 + 400} = \frac{1178}{3599}$$

$$r_1 = .327$$

$$2/\sqrt{N} = 2/\sqrt{5} = .895$$

$.327 < .895$ ∴ No significant autocorrelation exists.

Shewart Technique Computations

X	X^2
0	0
33	1089
67	4489
67	4489
67	4489
$\Sigma X = 234$	$\Sigma X^2 = 14,556$

$\bar{X} = 47$

$(\bar{X})^2 = 2209$

$$S = \sqrt{\frac{\Sigma X^2}{N} - \bar{X}^2}$$

$$S = \sqrt{\frac{14,556}{5} - 2209}$$

$$S = \sqrt{702.2} = 26$$

two tailed:
- $2(S) + 47 = .05$ level
- $99\% = .05$ level

one tailed:
- $1.8(S) + 47 = .05$ level
- $93.8 = .05$ level

TABLE 2

	S_1	S_2	S-3	S-4	S-5	S-6	S-7	S-8
r_1	.35	.193	.299	.39	.184	0	-3.5	-.74
$2/\sqrt{N}$	.894	.894	.894	.894	.894	.894	.894	.894

#1

Name _____ Grade _____ Teacher _____

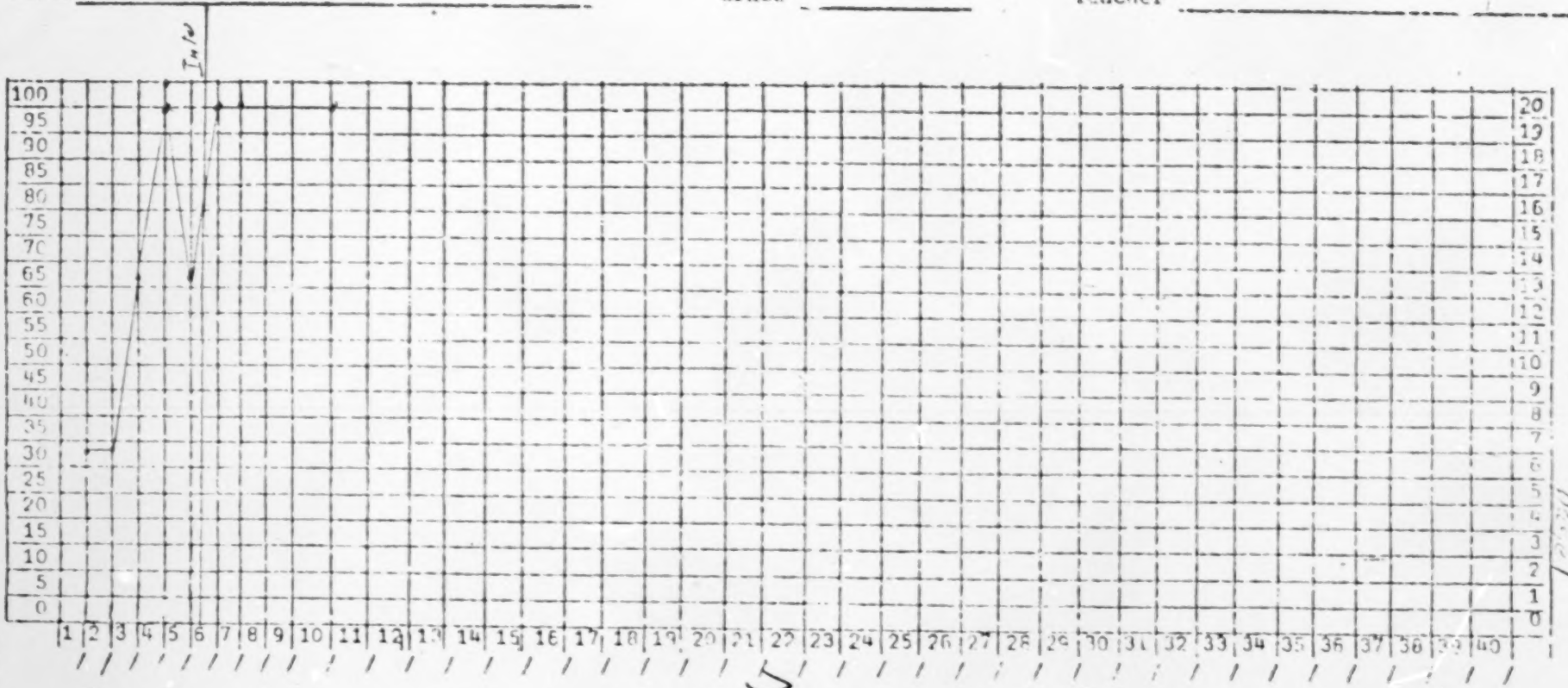


Figure 1, Page 1

Figure goes here

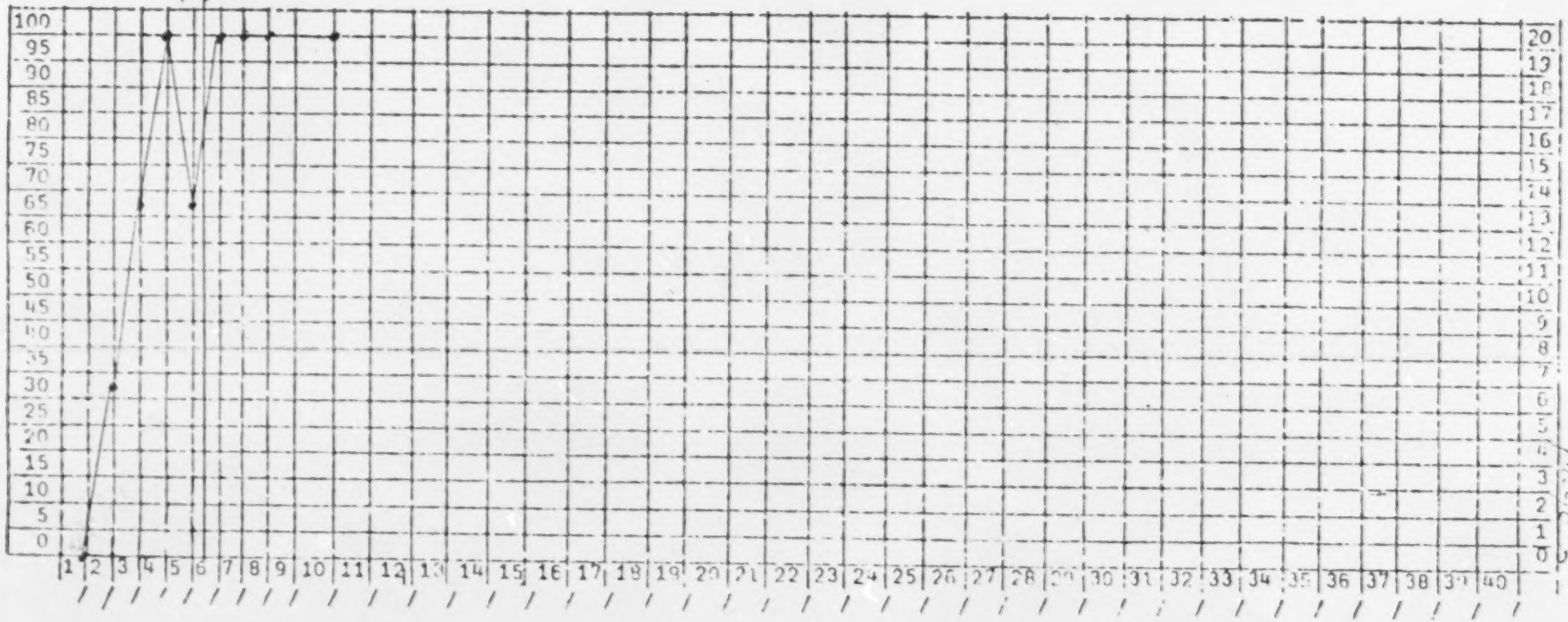
Intervention Type _____

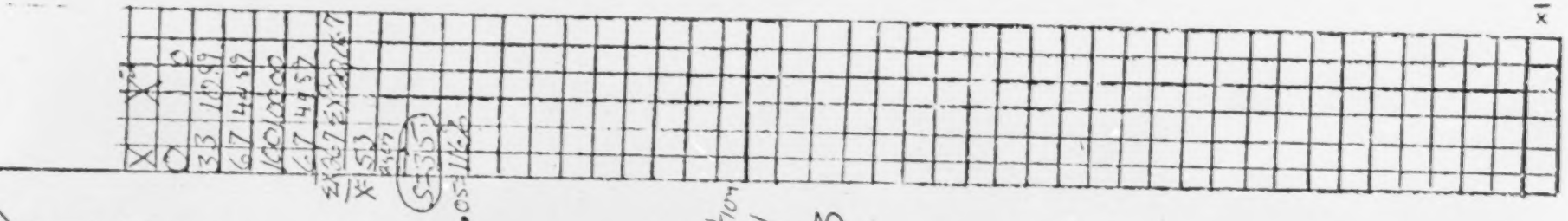
Reinforcement Menu

1. _____
2. _____
3. _____

10

Name #6 _____ Grade _____ Teacher _____





Intervention Type _____

Auto correlation
r1 = .864
r2 = .193

Reinforcement Menu

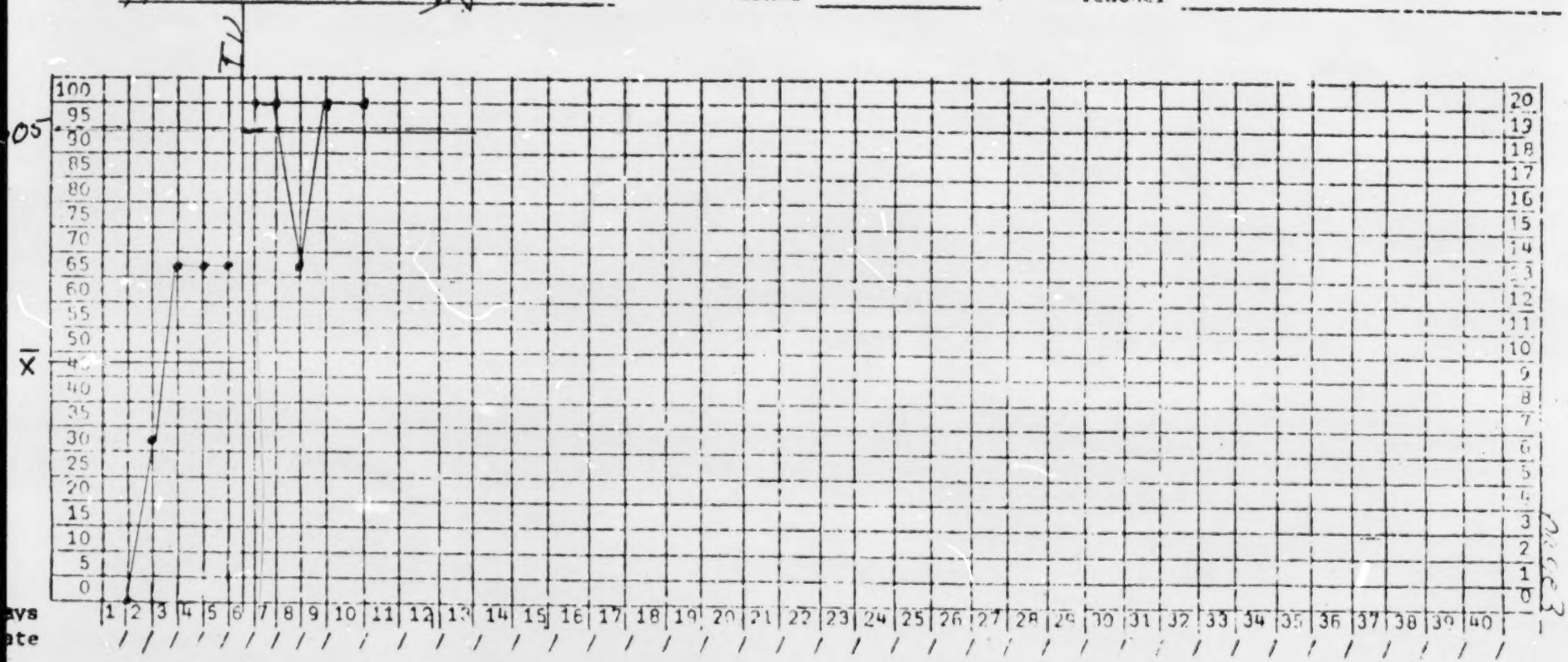
1. _____
2. _____
3. _____

I Tailed

11

12

Name #_____ Grade _____ Teacher _____



Intervention Type _____

AutoCorrelation
r_1 = .594
r_2 = .299

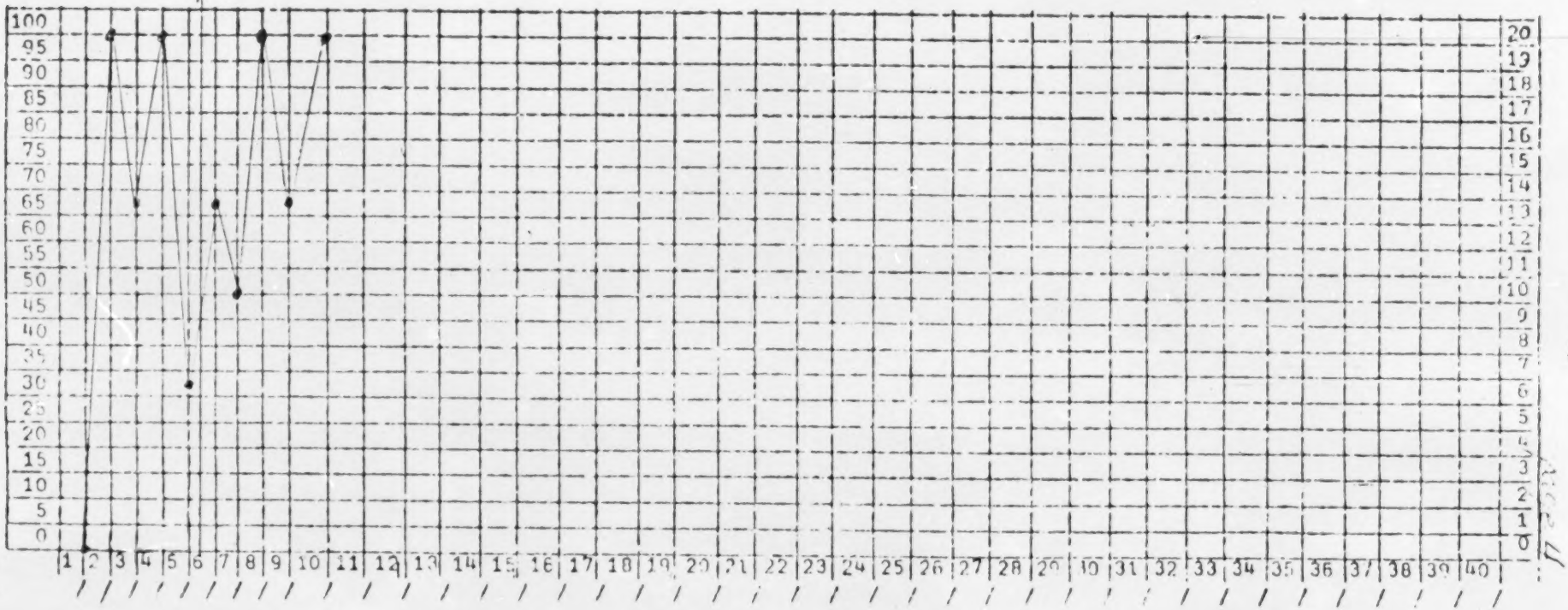
Reinforcement Menu

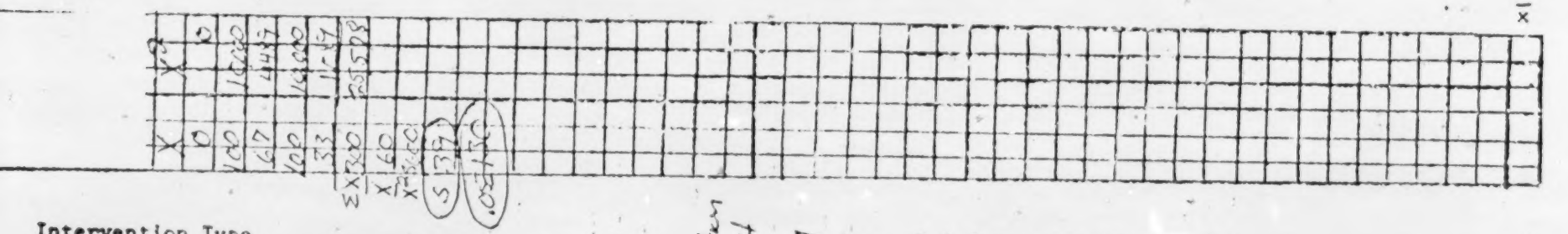
1. _____
2. _____
3. _____

Name #

Grade

Teacher





Intervention Type

Reinforcement Menu

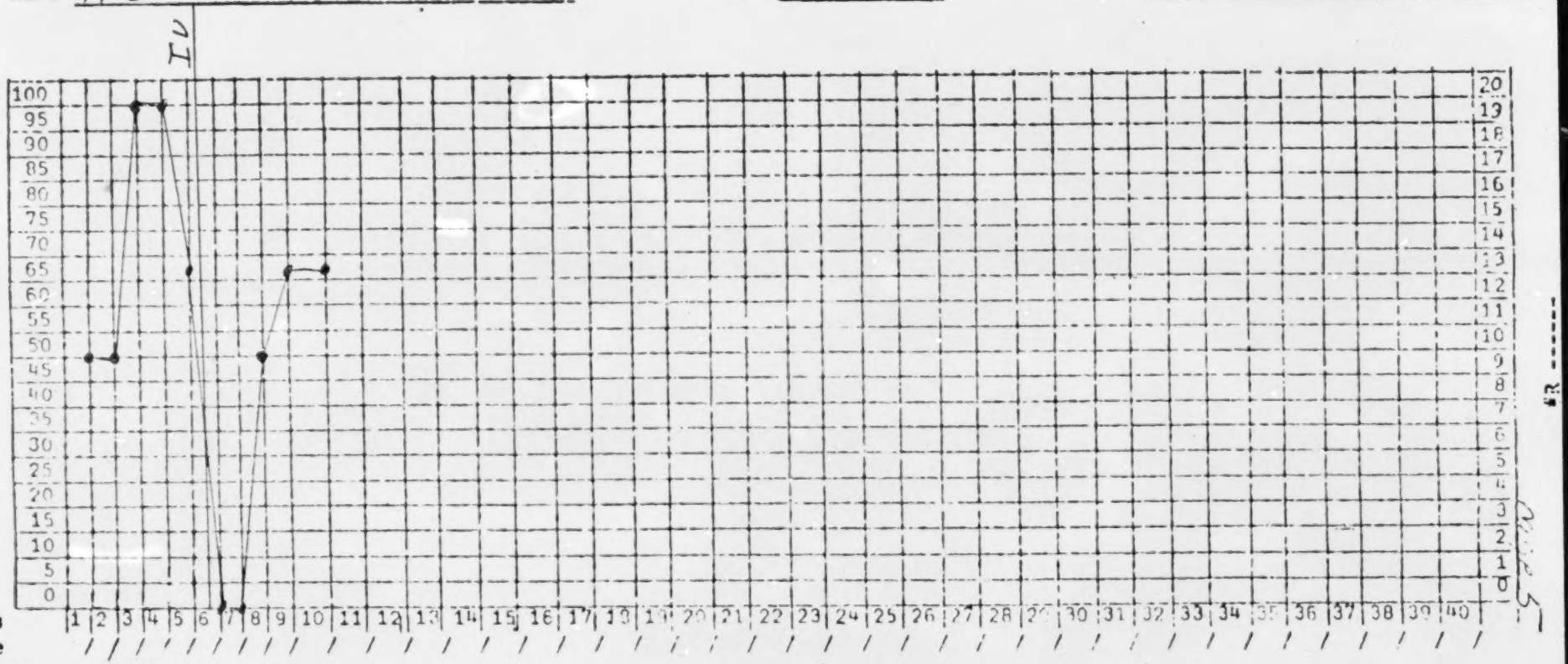
1.

2.

3.

Name #5

Grade _____ Teacher _____



ays
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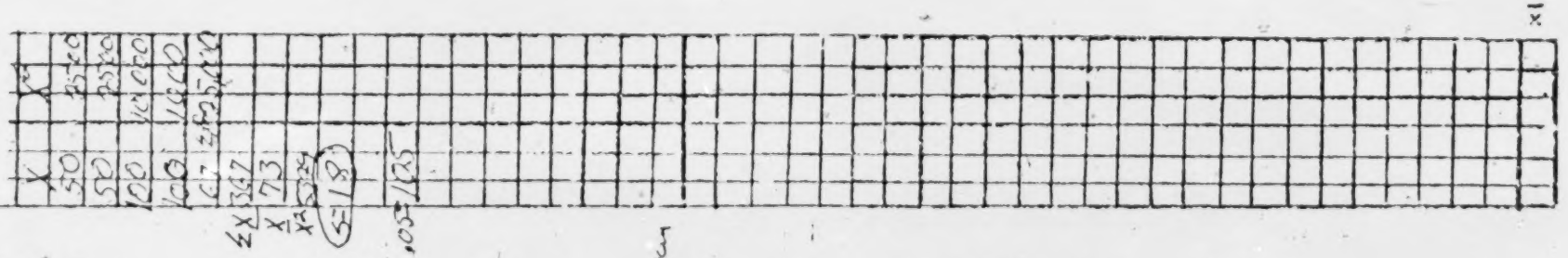
%



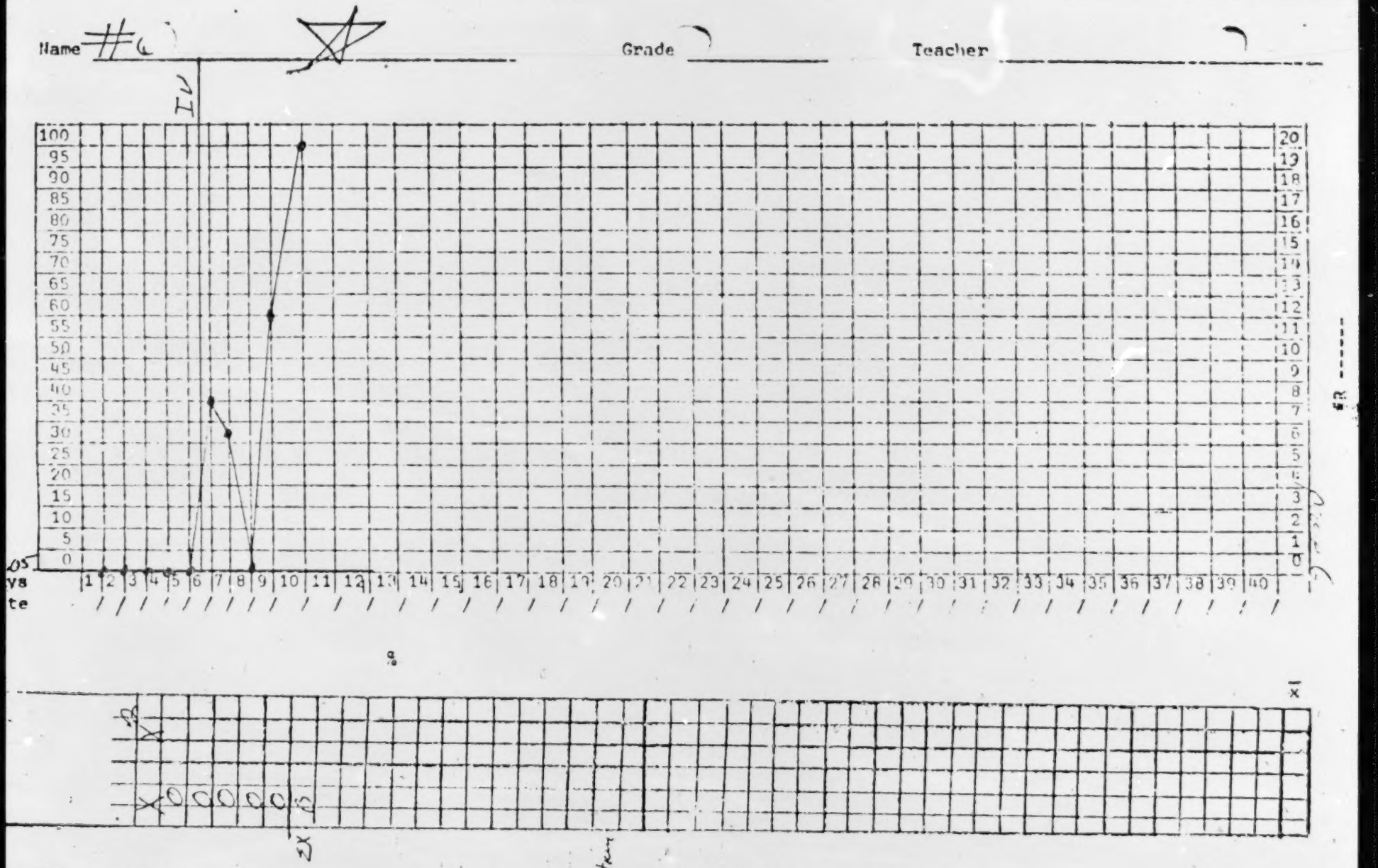
Intervention Type _____

Autocorrelation
$r_1 = .894$
$r_2 = .184$

Reinforcement Menu

1. _____
2. _____
3. _____

Name #6 Grade Teacher



Intervention Type

Autocorrelation
$\frac{r_2}{r_{SE}} = .894$
$r_2 =$ 0

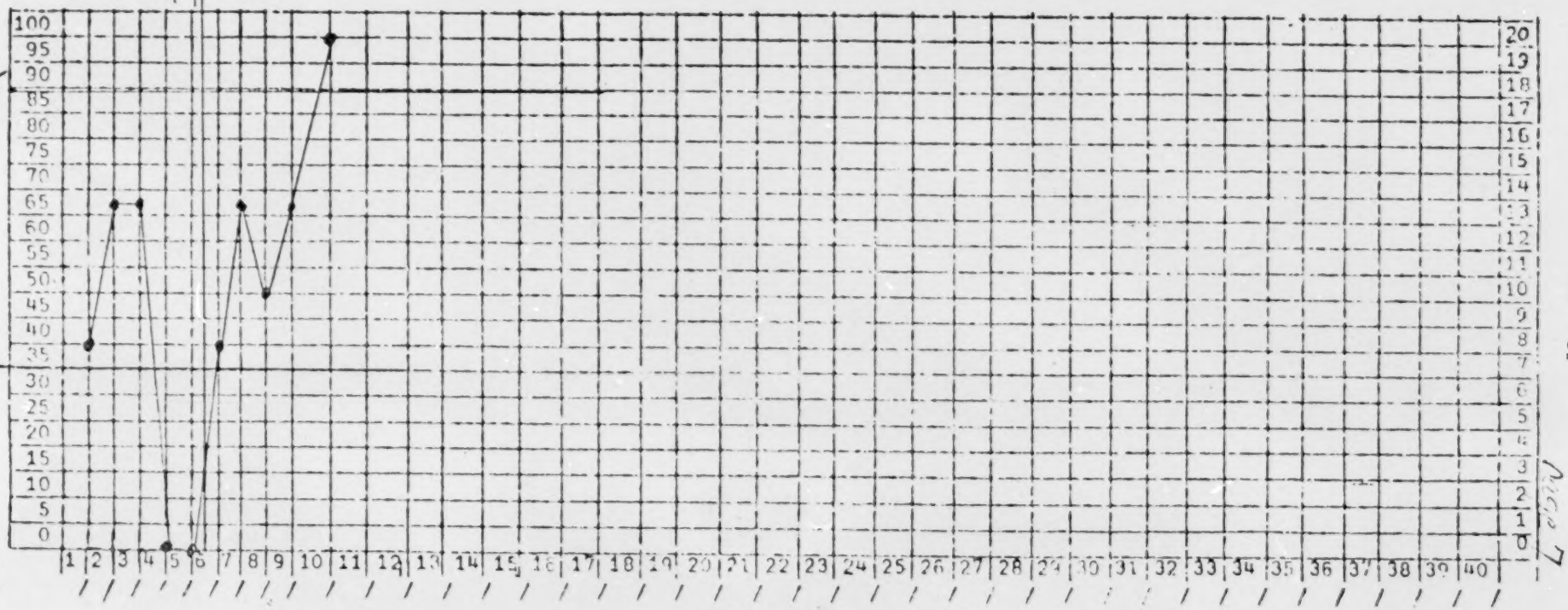
Reinforcement Menu

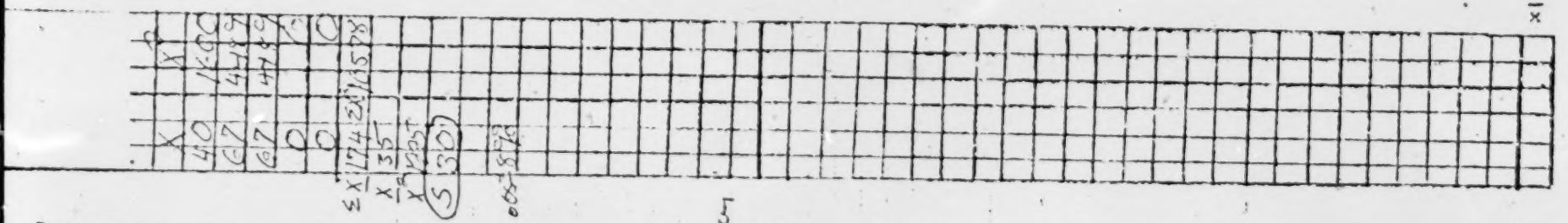
1.
2.
3.

19

20

Name #7 Grade _____ Teacher _____





Intervention Type _____

Auto Correlation
$\frac{2}{N-1} = .894$
$\frac{1}{N-1} = -3.5$

Reinforcement Menu

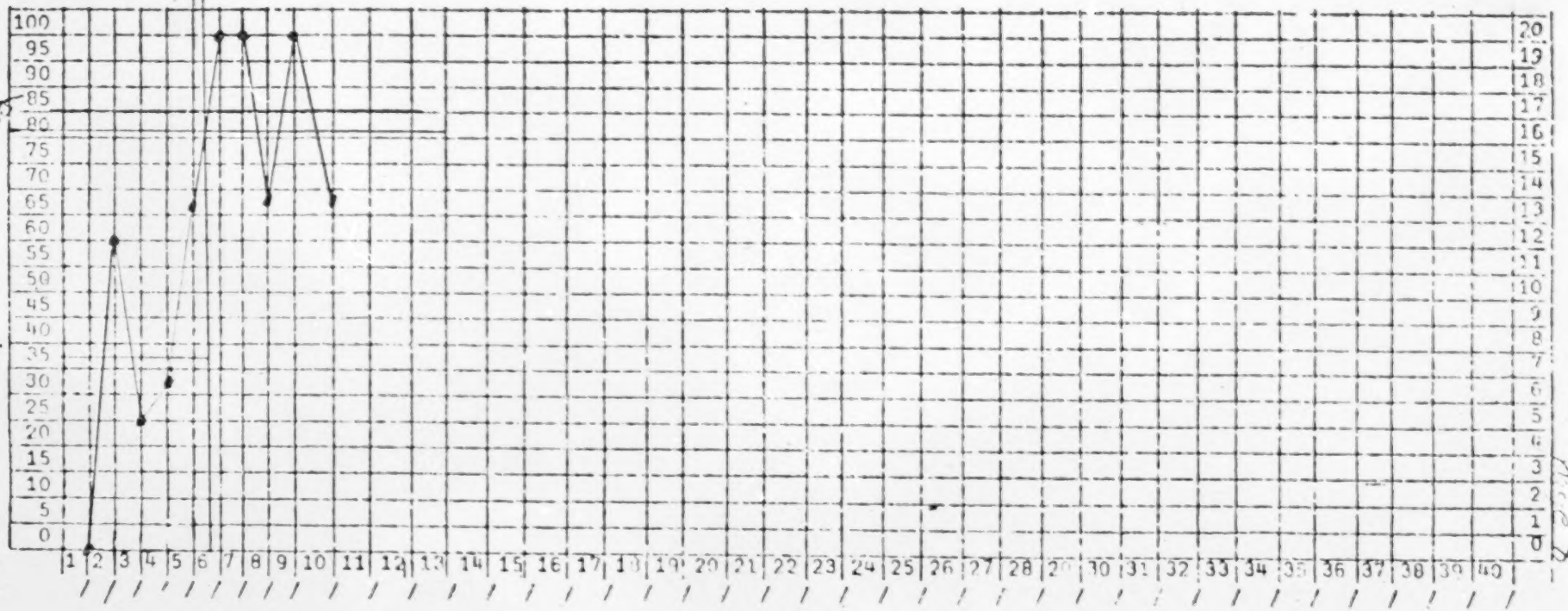
1. _____
2. _____
3. _____

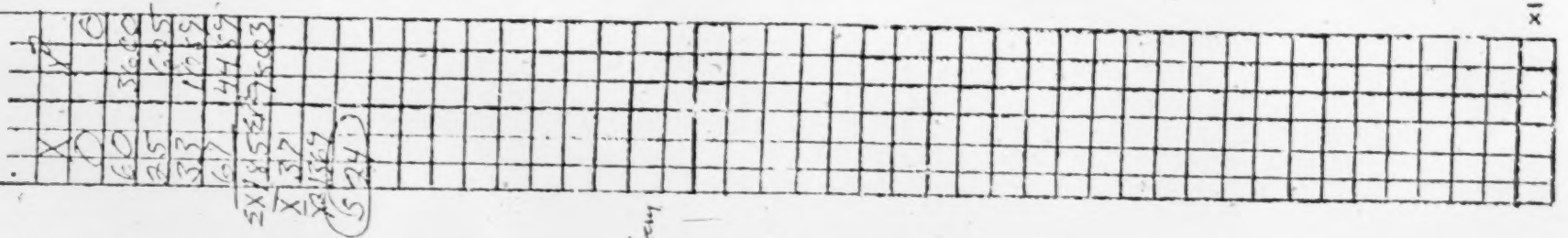
Name #

Grade

Teacher

IV





Intervention Type

Reinforcement Menu

1.

2.

3.

Auto correlations

$r_1 = .894$

$r_1 = -.74$